ENERGY SENSITIVE SUBDIVISION DESIGN AND EVALUATION

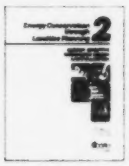
86-01564/

This booklet forms part of the kit
ENERGY CONSERVATION THROUGH LAND USE PLANNING

The kit is a collection of materials designed to help those involved in developing and making decisions on energy sensitive subdivisions.

Each piece was designed for a particular purpose:

Planning and Development Strategies for Energy Conservation provides a general **overview** of energy conservation as it relates to land use planning.



Energy Sensitive Subdivision Design and Evaluation provides a **process** for identifying and utilizing opportunities for energy conservation in subdivision design.

Climatic Design and Data provides more detailed technical **information** and relevant data.

Copies of this kit may be obtained from:

Inter Agency Planning Branch
Planning Services Division
Alberta Municipal Affairs

8th Floor, Jarvis Building
9925 - 107th Street
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ENERGY SENSITIVE SUBDIVISION DESIGN AND EVALUATION

Booklet #2 in the series

Energy Conservation through Land Use Planning

Inter Agency Planning Branch
Planning Services Division
Alberta Municipal Affairs
September, 1985

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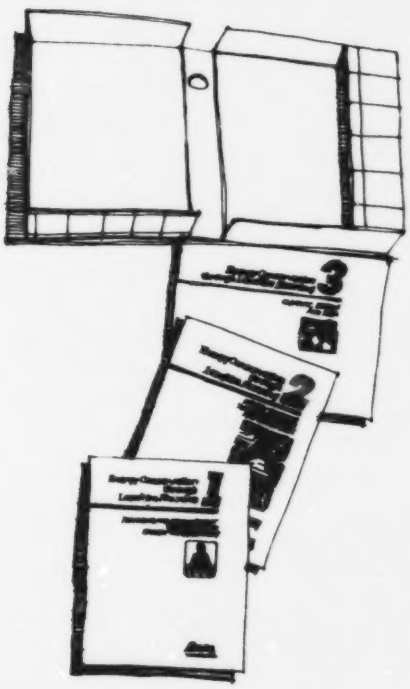
Introduction

During the past several years, a growing number of Alberta builders have emerged as providers of energy efficient homes. This trend has been stimulated by increasing consumer interest and government grant and education programs available to the Province's homebuilders.

As the experience of builders of energy efficient housing has broadened, so has recognition that the correct site conditions must be present in order for the full potential of energy savings to be realized. As a result, builders are seeking out sites that have been planned with energy conservation opportunities.

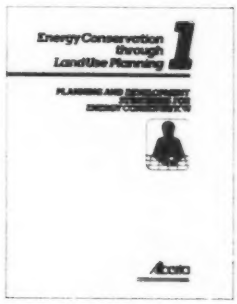
This package of information: — **ENERGY CONSERVATION THROUGH LAND USE PLANNING** — was developed in response to the need for technical guidance in the design and evaluation of building sites, so as to make them as sensitive to energy conservation opportunities as possible. The information has been packaged in a "kit" format to enable a variety of users to find the materials appropriate to their understanding and interest. Thus there are materials for elected officials (booklet #1: Planning and Development Strategies for Energy Conservation); subdivision designers and evaluators (booklet #2: Energy Sensitive Subdivision Design and Evaluation); and for those requiring detailed technical information and Alberta data (booklet #3: Climatic Design and Data). It is hoped that by presenting these materials in one package, the user will be better able to find the level of information appropriate to the decision being considered.



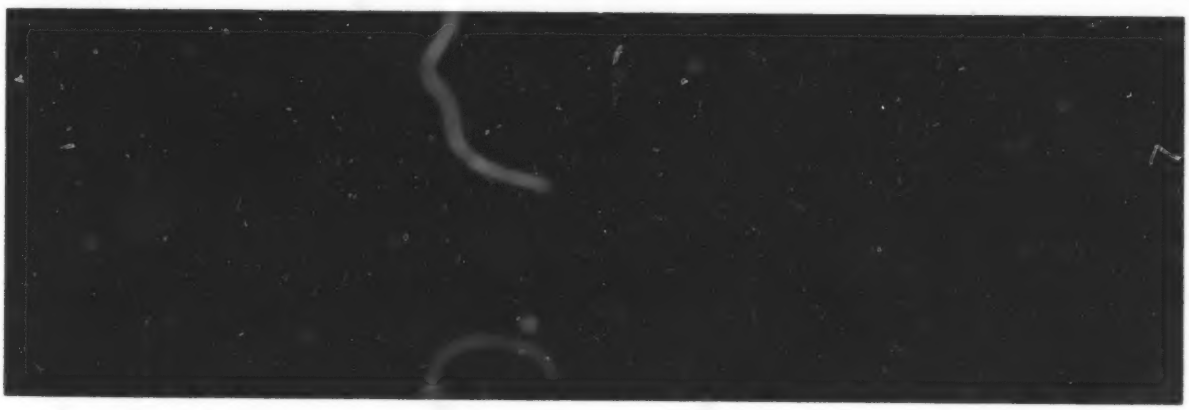
Kit Components

The Kit **ENERGY CONSERVATION THROUGH LAND USE PLANNING** consists of three components:

1. Planning and Development Strategies for Energy Conservation

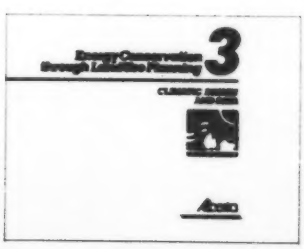


The booklet **Planning and Development Strategies for Energy Conservation** provides a general overview of energy conservation as it relates to land use planning. Its purpose is to give municipal planners, administrators, elected officials and the public a broad understanding of the many opportunities for saving energy present in land use planning; specifically in the area of new subdivision and development.



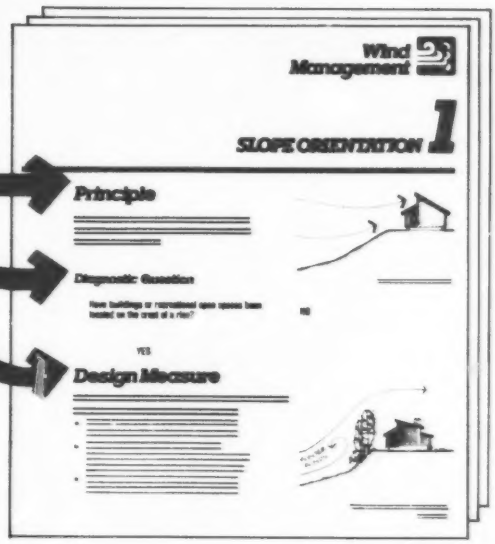
3. Climatic Design and Data

Climatic Design and Data provides more detailed technical information on energy efficiency through site design, the effects of good site design upon building energy use and then presents data related to specific design measures. A technical appendix containing climate data for Alberta is also provided.



How This Handbook is Organized

This design and evaluation handbook forms the heart of the Kit. The handbook consists of a series of **Principles** describing opportunities on a site necessary for creating conditions favorable to achieving energy efficient development or to identifying problem areas that should be addressed. Each **Principle** is accompanied by a **Diagnostic Question** that evaluates whether or not these conditions exist on the site. If desirable conditions are not present on the site, then **Design Measures** to be considered are provided.



There are two types of **Design Measures**:

- suggestions on which particular aspects of the plan should be reconsidered or altered.
- measures that may be taken to lessen potential negative effects.

The **Principles** are grouped according to the three major elements that can be utilized to realize energy savings through site design. These are:

- CLIMATIC DESIGN - ways to manage the negative effects of such things as winter winds, cold air flow; and methods to utilize positive conditions such as proper solar exposure.
- MATERIALS CONSERVATION - measures to lessen the energy needed initially and on a continuing basis for site preparation, paving, storm water management and landscaping.
- PEDESTRIAN CIRCULATION - on-site methods that result in reduced dependence on low occupancy private cars.

Information about a site and a proposed project is necessary in order to respond to many of the **Diagnostic Questions** in the design sequence. A listing of the specific information required and the resources from which this information can be obtained are provided at the beginning of each design sequence.

How to Use This Handbook

This handbook is intended for use by public agency planners and development officers as well as builders, architects, engineers and site designers. Its organization has been based on the needs of these users for two types of application; site design and plan evaluation.

1. As an Aid in the Site Design Process

The entries under **Principles** are intended to serve as design guidelines which suggest approaches for road layout and widths, site preparation, lot orientation, the placement of wind buffers and other characteristics which affect energy use.

The design process tends to be non-linear. The order of the steps in **Principles** need not be rigorously followed, although this is recommended for the beginning designer.

The resource book (booklet #3) contains, in detail, rationale for the design principles and additional technical information to aid the designer to apply these principles.

2. As an Aid to the Site Plan Review Process

The **Diagnostic Questions** are planned to serve as a structure for determining the degree to which opportunities for achieving greater energy efficiency have been recognized and responded to in a proposed site plan.

Their order has been selected according to the relative importance of each group of site design approaches in helping to realize building energy savings.

The entries under **Design Measures** are intended to suggest design approaches that should be taken by the project proponent where favourable site conditions cannot be achieved.

CLIMATIC DESIGN PRINCIPLES

Wind Management

Cold Air Flow

Solar Exposure

Wind Management

The pattern of wind movement over a site can be complex. Structures, variations in topography and vegetation often cause turbulence. In virtually all locations in the province, moderate (8 - 12 km/h) to strong (12 - 33 km/h) winds occur during the winter season, from November through March.

The placement of walls, windows and open spaces relative to the direction of predominant winter or summer winds, can significantly affect space heating and cooling needs.

For example, in an average size house, about 60% of air leakage occurs through spaces between foundation and floor, electrical and plumbing penetrations and 20% through windows and doors. Heat loss varies markedly as a function of exposure to wind and its velocity.

Many of the negative effects that can result from winter winds can be lessened and opportunities for natural ventilation increased, by the purposeful use of landforms, building mass, fences, walls and vegetation as windbreaks.

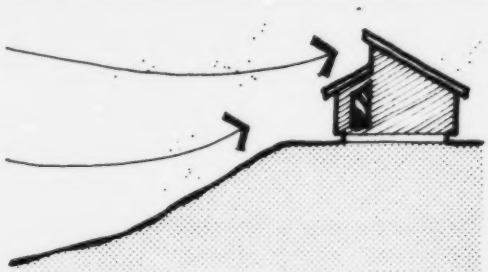
To complete the **Diagnostic Question** sequence for **wind management**, the following information will be necessary.

Information Required	**Sources**
1. predominant winter wind direction	CLIMATIC DESIGN AND DATA (p. 49)
2. predominant summer wind direction	CLIMATIC DESIGN AND DATA (p. 49)
3. slope orientation	Topo-Climatic Map, CLIMATIC DESIGN AND DATA (p. 55)
4. building and lot location	Site Plan (as submitted)
5. street orientation	Site Plan (as submitted)
6. location of streets and open spaces	Site Plan (as submitted)
7. existing or planned vegetation	Site Plan (as submitted)

1 SLOPE ORIENTATION

Principle

Buildings or recreational open spaces should not be located on the crest of a rise or other high exposed areas unless measures are taken to mitigate winter winds.



Building located on crest of rise exposed to winter winds

Diagnostic Question

[redacted]

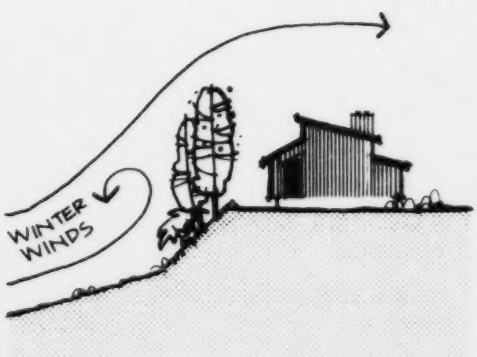
NO

YES

Design Measure

Where buildings cannot be relocated from the crest of a rise, vegetative or man-made windbreaks should be used.

- Small variations in terrain can cause inordinately large modifications in microclimate.
- Land forms can have a major effect on winds. Wind speeds at the crest of a hill are greater than those on level land.
- Where the boundary layer of air is compressed as it passes over a ridge wind speed can be 20% greater than on the slopes.



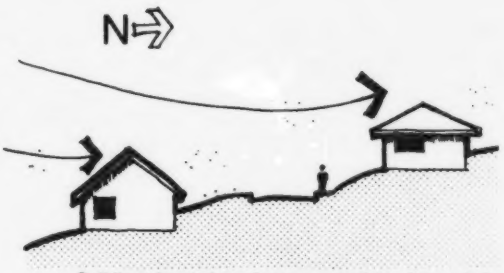
Windbreaks used to deflect winds from buildings located on crest of hills

[redacted]

2 SLOPE ORIENTATION

Principle

Buildings or recreational open spaces can be located on south, southeast and southwest facing slopes if measures are taken to moderate winter winds. They should not be located on north facing slopes.



Buildings located on slopes exposed to winter winds

Diagnostic Question

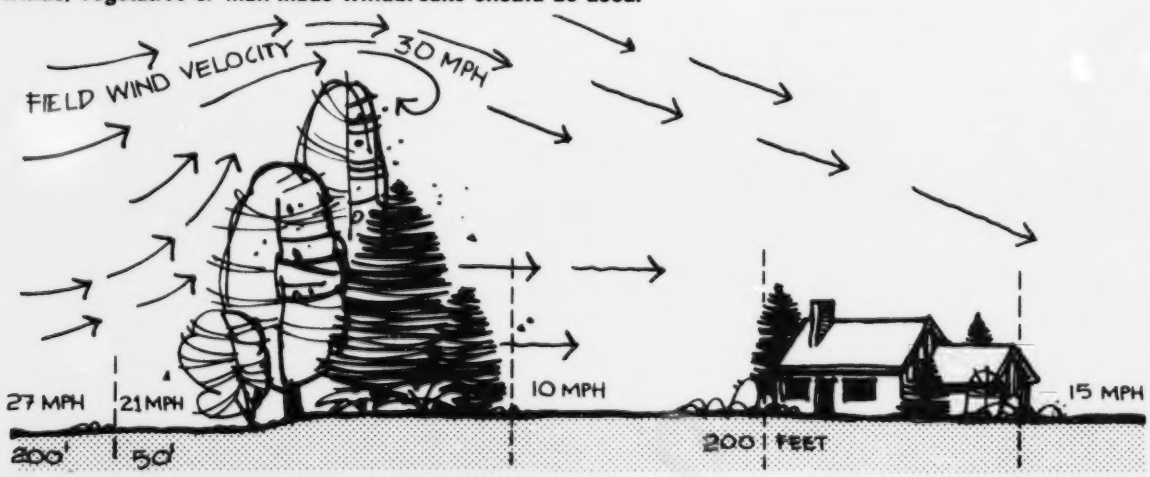
[redacted]

NO

YES

Design Measure

Where buildings are located on slopes exposed to winter winds, vegetative or man-made windbreaks should be used.



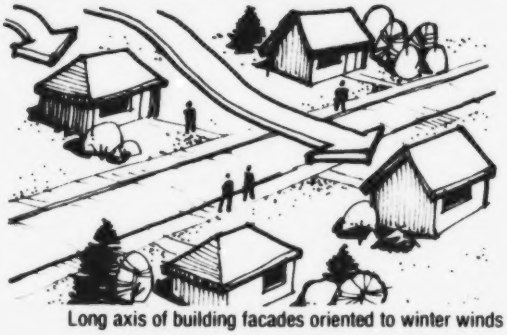
Windbreaks used to channel winter winds

[redacted]

3 LOT LOCATION

Principle

Lots should be oriented so that building facades are not exposed to winter winds. Where winds originate from the south, lots should be oriented southeast.



Long axis of building facades oriented to winter winds

Diagnostic Question

[redacted]

NO

YES

Design Measure

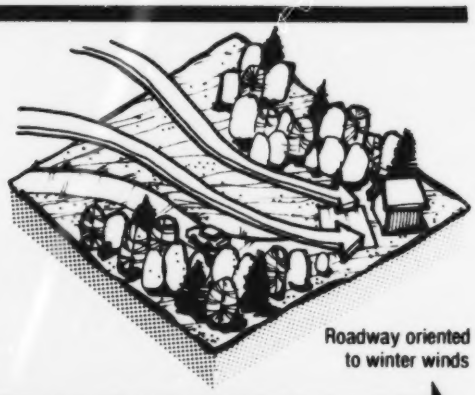
If lots cannot be reoriented, buildings and vegetation should be sited to function as windbreaks.

[redacted]

LOT LOCATION 4

Principle

Roadways should not be oriented in the same direction as prevailing winter winds in order to avoid channelization.



Roadway oriented to winter winds

Diagnostic Question

[redacted]

NO

YES

Design Measure

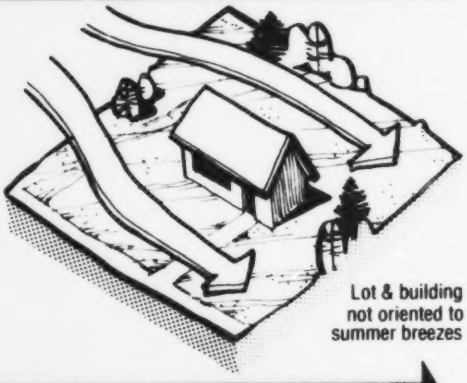
If roadways cannot be reoriented, vegetative windbreaks should be used.

[redacted]

5 SUMMER VENTILATION

Principle

Lots or buildings should be oriented so as to take advantage of summer breezes.



Lot & building not oriented to summer breezes

Diagnostic Question

[redacted]

YES

NO

Design Measure

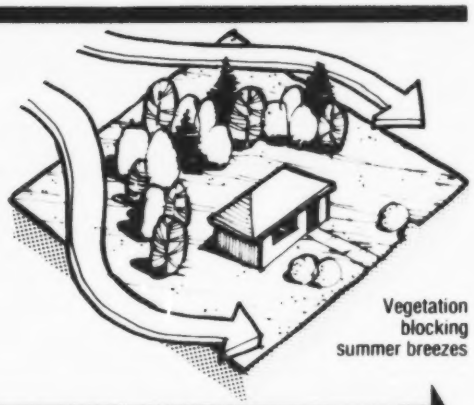
If lots and buildings cannot be reoriented, earth berms or vegetation should be used to redirect summer breezes.

[redacted]

6 SUMMER VENTILATION

Principle

Existing or planned vegetation should be located so as not to block the flow of summer breezes.



Vegetation blocking summer breezes

Diagnostic Question

[redacted] NO

YES

Design Measure

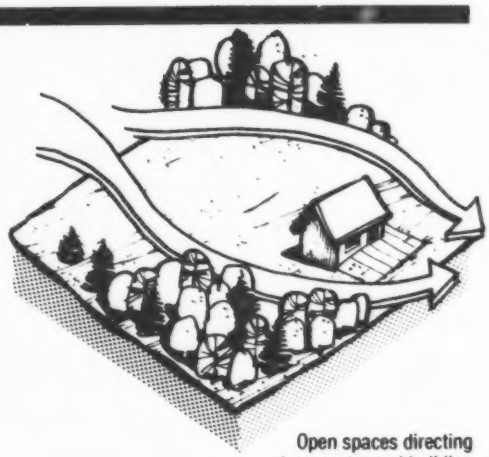
Vegetation should be thinned or relocated.

[redacted]

7 SUMMER VENTILATION

Principle

Open spaces and streets should be located so as to channel summer breezes.



Open spaces directing breezes toward building.

Diagnostic Question

YES

NO

Design Measure

Relocate open spaces or roads to channel summer breezes

Cold Air Flow

Exposure to cold air can increase the magnitude and rate of heat loss and therefore, the need for space heating.

Cooler air tends to be denser and flows downward displacing warmer air at the bottom of a slope. Building placement, vegetation, land forms or changes in grade can block the passage of the cold air, creating a damming effect.

Low lying areas which do not have an outlet can retain cold air and become pockets for fog and frost.

Planning for site preparation, lot and roadway locations, and landscaping should consider ways to avoid negative effects from this cold air so that the flow is directed across a site.

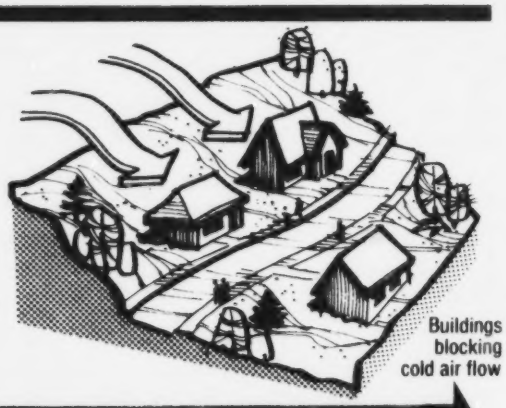
To complete the **Diagnostic Question** sequence for **cold air flow** the following information will be necessary.

Information Required	**Sources**
1. cold air flow patterns	Topo-Climatic Map, CLIMATIC DESIGN AND DATA (p. 55)
2. lot location	Site Plan (as submitted)
3. locations of low areas or hollows	Topographic Map

8 BUILDING LOCATION

Principle

Buildings should not be located so as to block the natural downhill path for night-time cold air flow



Buildings blocking cold air flow

Diagnostic Question

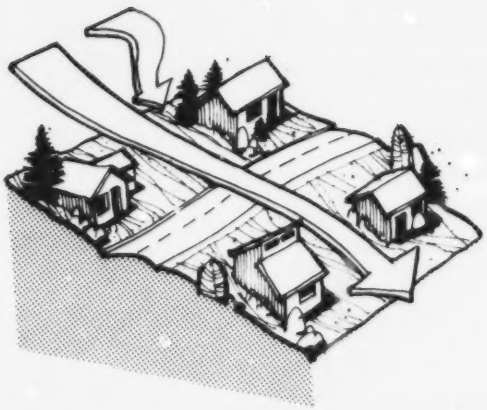
NO

YES

Design Measure

Building should be located and land forms planned so as to direct the downhill flow of cold air along natural channels.

- Cold air tends to be denser and will therefore flow downward; displacing warmer air at the bottom of a slope. Differences in temperature at the top and bottom of a slope of as great as 6 to 10 degrees have been determined as a result of this effect.
- Many times cold air will flow down to valley floors in the late afternoon or early evening.
- Buildings, land forms or changes in grade can impede the flow of air creating a damming effect.

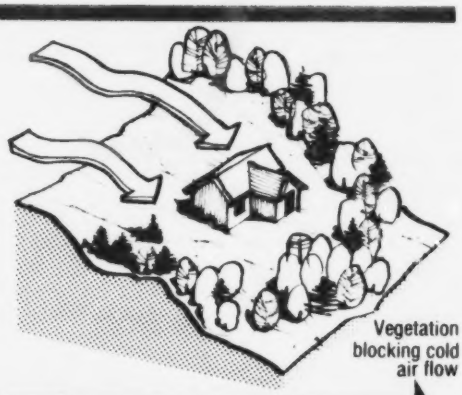


Buildings & land form channeling cold air flow

9 VEGETATION LOCATION

Principle

Existing or planned vegetation should not be located so as to block the natural downhill path for night-time cold air flow



Vegetation blocking cold air flow

Diagnostic Question

[redacted] NO

YES

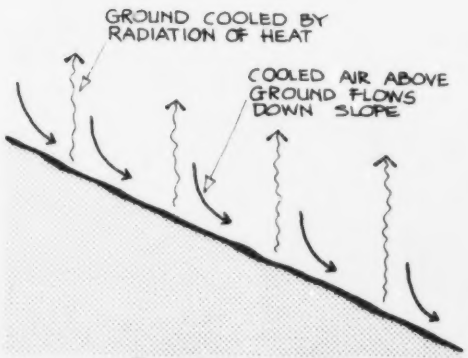
Design Measure

Foliage can be thinned or placed so as to direct the downhill flow of cold air along natural channels.

- Dense foliage placed on a slope can trap and hold cold air flow upwind creating frost pockets. Deciduous or loose plants create cool spaces on the downwind side by filtering the air.

Vegetation channelling cold air flow

[redacted]



Flow patterns for night-time cold air flow

BUILDING AND OPEN SPACE LOCATION 10

Principle

Buildings or recreational open spaces should not be located in low areas or hollows

Building and open recreation space in low areas

Diagnostic Question

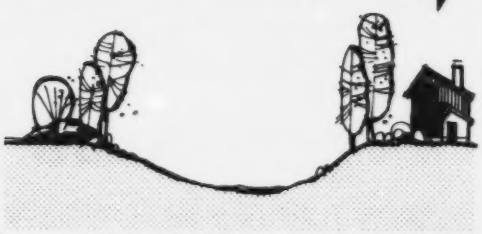
NO

YES

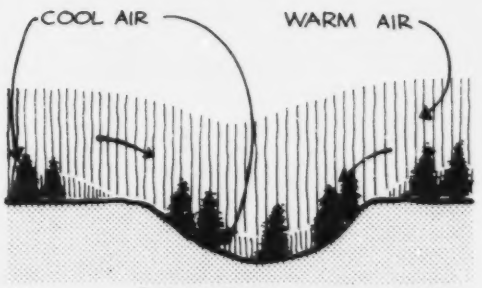
Design Measure

Cold spots and low-lying areas should be avoided

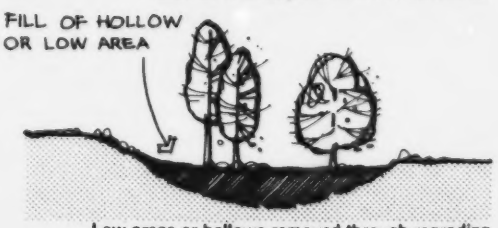
- Land forms or changes in grade can serve to impede the flow of air through a damming effect.
- Concave terrain areas which do not have an outlet can become cold air spots during the night.



Low areas left clear of buildings or recreational open space



Cold air or frost pockets in low elevations



Low areas or hollows removed through regrading

Solar Exposure

The need to rely solely upon natural gas or electricity to provide energy for hot water, space heating or cooling can be reduced in buildings designed to take best advantage from solar radiation.

Experience in Alberta suggests that passive solar systems can provide 20-30% of the annual space heating load for a single family detached home and 40-60% of annual water heating needs.

Street location will strongly determine lot shape and the resultant orientation of buildings. Even if optimum building orientations, (12° - 15° east of south) can be achieved, topography, fences, vegetation and structures can interfere with the availability of solar radiation.

To complete the **Diagnostic Question** sequence for **solar exposure**, the following information will be necessary.

Information Required	**Sources**
1. slope orientation	Topo-Climatic Map, CLIMATIC DESIGN AND DATA (p. 55)
2. lot location	Site plan (as submitted)
3. street and lot orientation	Site plan (as submitted)

SLOPE ORIENTATION 11

Principle

Buildings and outdoor recreational spaces should be located on south facing slopes, location on north slopes should be avoided.

Buildings located on south facing slopes

Diagnostic Question

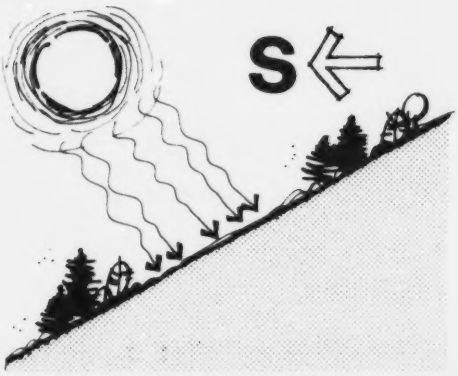
NO

YES

Design Measure

Buildings and recreational open spaces should only be located on south, east or west slopes.

- South slopes are best for solar exposure. Since the sun is in the southern sky in the northern hemisphere, south slopes are most nearly perpendicular to the sun's rays and can capture a greater amount of winter solar radiation than other slope orientations.
- Because of shorter shadow lengths, buildings can be sited closer to one another without obstructing solar exposure. Since south slopes absorb more radiation, they tend to be warmer and can moderate winter temperatures.



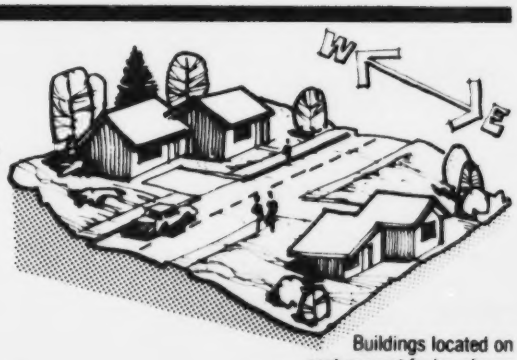
Angle of sun as it strikes south slope

Shadow length on south slope

SLOPE ORIENTATION 12

Principle

If buildings are adequately shaded in summer, then east or west facing slopes can be suitable for gaining solar exposure.



Buildings located on east or west facing slopes

Diagnostic Question

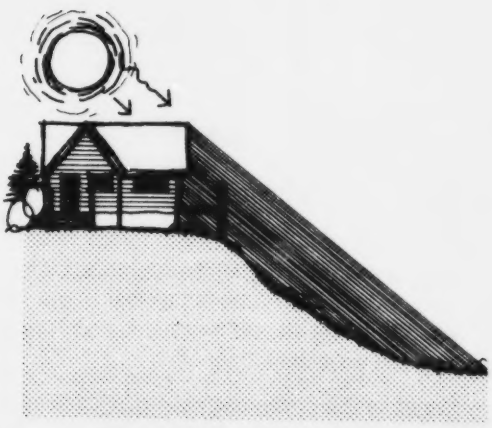
YES

NO

Design Measure

Buildings should be located on south, east or west slopes.

- East and west slopes get more sunlight in summer and less in winter than south slopes. East slopes heat up earlier in the morning and are cooler in the afternoon. West slopes stay cooler in the morning and are hotter in the afternoon. Overheating during summer months can become a problem during later afternoon hours. If a building is adequately shaded in summer, then east and west slopes can be suitable.
- North slopes are the least ideal for solar exposure. The oblique solar angle means that this slope tends to be cooler in the winter months. Shadow lengths are extremely long, making site planning to preserve solar exposure difficult.

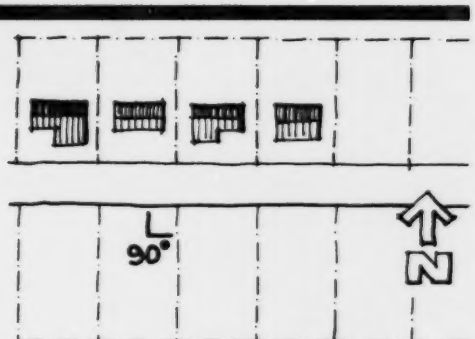


Angle of sun and shadow lengths on north slopes

SHADING, STREET AND LOT LOCATION 13

Principle

Streets should run east-west so that lots can be oriented north-south and building facades can face south.



Orientation and lot layout of east-west oriented streets

Diagnostic Question

[redacted]

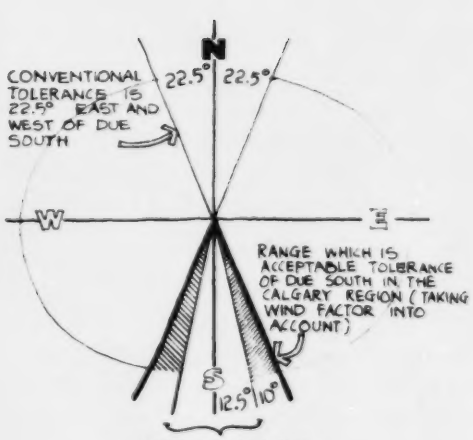
YES

NO

Design Measure

Streets should be reoriented as much as practicable to run east-west.

- Solar radiation strikes differently oriented surfaces with varying intensity, a building will benefit if its walls and roof are oriented to receive this heat in winter and be shaded in the summer.
- In most conventional single family developments the long axis of each lot is perpendicular to the street, while the long axis of the home is parallel to the street. Ideally, each building should be oriented with its long axis running east-west.
- Because the outdoor air temperatures are lower in the morning and peak in the mid-afternoon, a house should be oriented 12-15 degrees east of south.



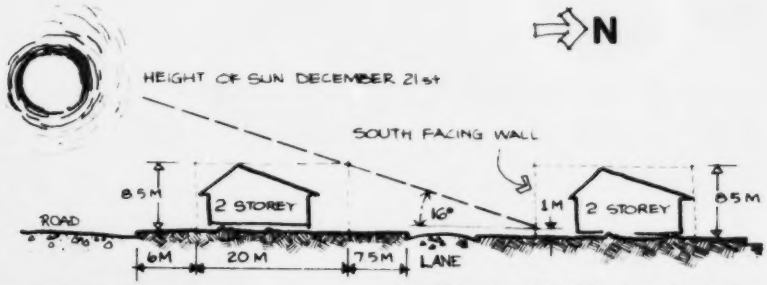
Optimum orientation

[redacted]

SHADING, STREET AND LOT LOCATION 14

Principle

Structures should be sufficiently spaced to avoid casting shadows on buildings located to their north.



Correct spacing of buildings to avoid shadows

Diagnostic Question

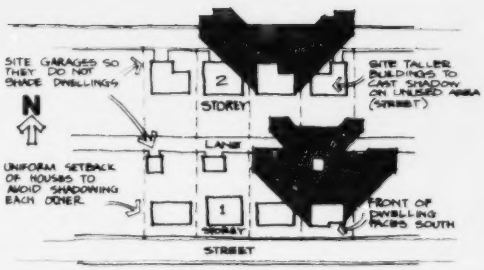
NO

YES

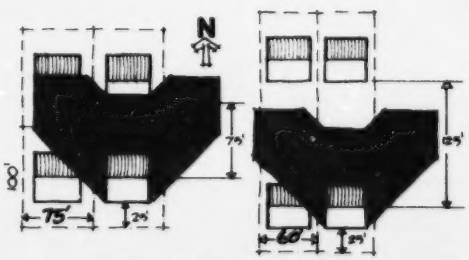
Design Measure

Uniform setbacks should be established. Frontage should be reduced. Rear yard setbacks should be increased.

- The location of garages, carports and other accessory buildings must be planned so that they do not shade the south walls of buildings that could benefit from solar exposure. Accessory structures can be sited to the north of a main building. When they are sited to the south of a main building, they must be set far enough back so that their shadows do not encroach.
- Reducing the frontage of lots on east-west streets is one way to improve solar exposure. Keeping lot size constant while reducing frontage results in lots that are narrower from east to west and longer from north to south, with more distance between buildings.


SITE GARAGES SO THEY DO NOT SHADE DWELLINGS
N
2 STOREY
SITE TALLER BUILDINGS TO CAST SHADOW ON UNUSED AREA (STREET)
LANE
UNIFORM SETBACK OF HOUSES TO AVOID SHADOWING EACH OTHER
1 STOREY
FRONT OF DWELLING FACES SOUTH
STREET

Buildings located on east or west facing slopes.

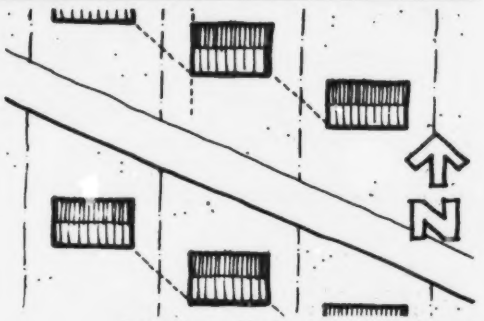


Reduction of frontage of east-west streets

SHADING, STREET AND LOT LOCATION 15

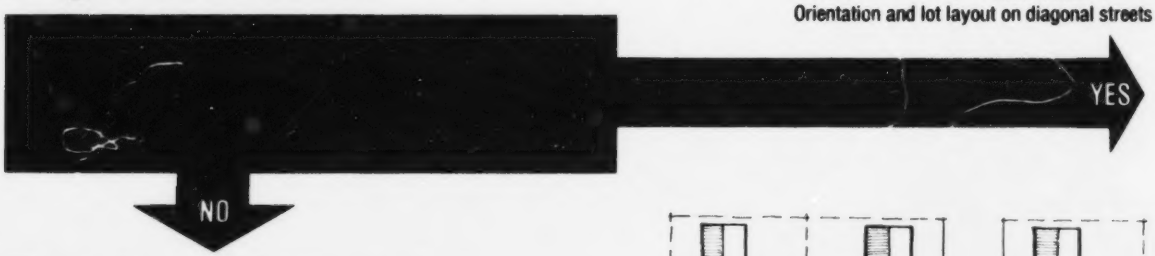
Principle

Lots on streets running diagonally northwest to southeast can be planned to have good solar exposure.



Orientation and lot layout on diagonal streets

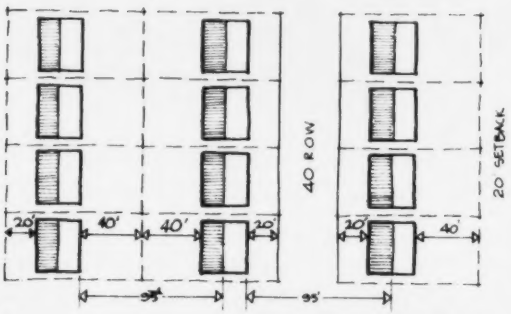
Diagnostic Question



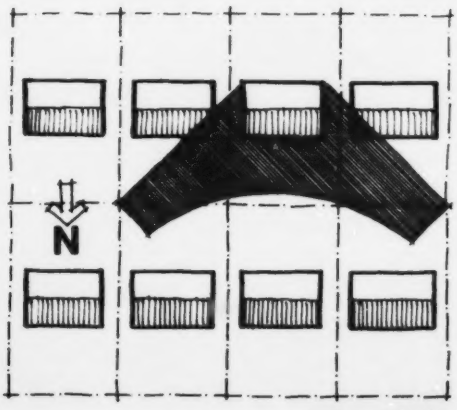
Design Measure

Plan building siting to take advantage of the potential for solar exposure.

- By reducing the front yard setback and increasing the rear yard setback, the distance between houses that back on each other and houses that face each other can be made equal. This results in all buildings moving closer to the street improving solar exposure on the south side of streets.
- Under typical setback practice, buildings may be staggered in distance from the street or lot line as long as they meet minimum yard requirements. This can result in a shading problem in the morning or afternoon. Uniform building setback can improve solar exposure. If all the south walls line up, then buildings will not shade each other.



Increase of rear yard setbacks

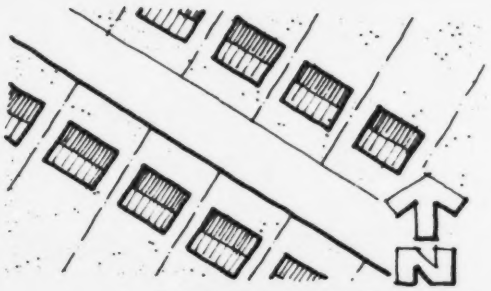


Uniform setbacks

SHADING, STREET AND LOT LOCATION 16

Principle

Structures located on streets that run diagonally should be sufficiently spaced to avoid casting shadows on buildings located to their north.



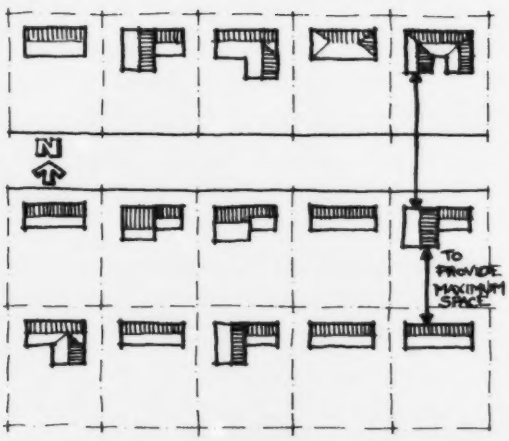
South facades shaded in diagonal streets

Diagnostic Question

Design Measure

A zero lot line approach can be used or set backs can be adjusted.

- In a zero lot line approach buildings can be sited so that they abut property lines. This would provide the greatest possible yard area to the south of each building.

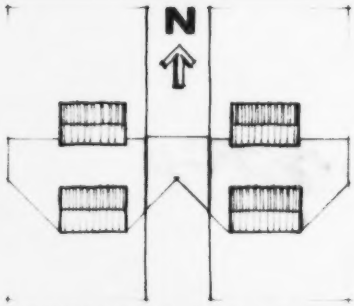


Adjusted setbacks for solar exposure

SHADING, STREET AND LOT LOCATION 17

Principle

Structures should be sufficiently spaced to avoid casting shadows on buildings located to their north on streets that run north-south.



South facades shaded on north-south streets

Diagnostic Question

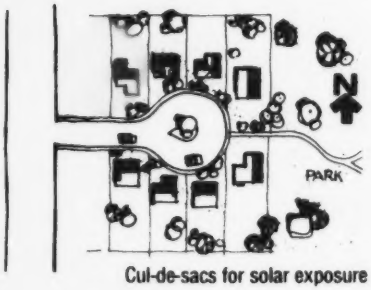
NO

YES

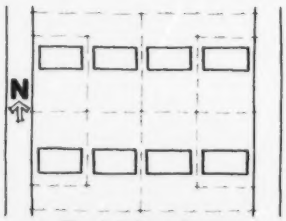
Design Measure

Cul-de-sacs and flag lot techniques should be used on lots located on north-south streets. Duplexes or other attached units should be located on lots located on north-south streets.

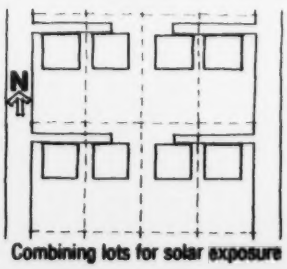
- Cul-de-sacs can be used as an approach to permit flexible lot orientation on streets that run north-south.
- The flag lot technique can be used when the streets are spaced so far apart that four lots can be run in an east/west direction with the "pole" of the flag connecting the inner lots to the street.
- Two lots that abut each other on the north or south could be replotted so as to increase the distances between buildings.



Cul-de-sacs for solar exposure



Flag lots for solar exposure

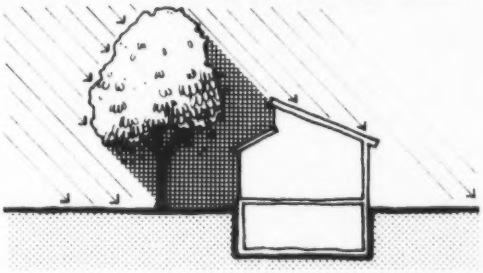


Combining lots for solar exposure

SHADING, STREET AND LOT LOCATION 18

Principle

Existing vegetation should be thinned and new vegetation located so as to avoid casting shadows on buildings located to their north.



Vegetation shading south facades of buildings

Diagnostic Question

[redacted] NO

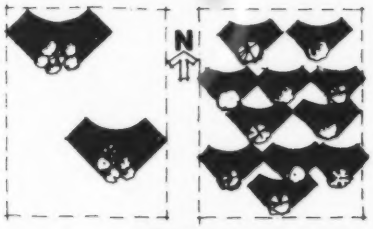
YES

Design Measure

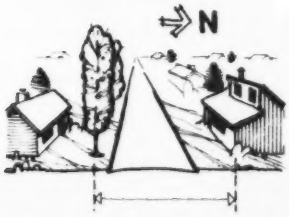
Grouping, selection and placement of trees should permit unobstructed solar exposure.

- Trees should be planted in groups since overlapping shadows will create less total shaded area than does the same number of separate trees.
- Taller trees should be planted on the south side of streets rather than on the north to avoid shading south facades of buildings.
- Trees which lose their foliage during winter months and whose trunks and bare branches will not significantly reduce solar exposure should be used to allow maximum solar exposure in the winter.

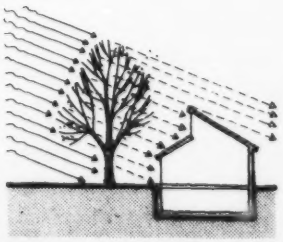
[redacted]



Planting of trees in groups



Placement of taller trees on south side of street



Selection of deciduous trees for solar exposure

MATERIALS CONSERVATION PRINCIPLES

Materials Conservation

Materials Conservation

Electricity and natural gas are required to power pumps and treatment facilities for sewage, and for purifying and providing water. Petroleum is used by equipment during site preparation and for maintaining roadways, parking areas and systems for managing storm water runoff.

Site planning can provide for storm water management on-site, lessening or eliminating problems such as overload, that could occur in a larger system.

On flat areas, the necessity to truck excavated dirt can be reduced, if the material is planned for use as earth berms to control winter winds. Terracing along natural contours or clustering can lessen requirements for grading.

Careful layout of roadways, consideration of narrower pavements, and grouping of parking off-street can increase the proportion of a site available for building and lessen maintenance.

To complete the **Diagnostic Question** sequence on **materials conservation**, the following information will be necessary.

Information Required	Sources
1. natural drainage pattern	Topographic Map
2. site contours	Topographic Map
3. building and lot location	Site plan (as submitted)
4 parking area location	Site plan (as submitted)
5. street layout	Site plan (as submitted)

DRAINAGE AND SITE PREPARATION 19

Principle

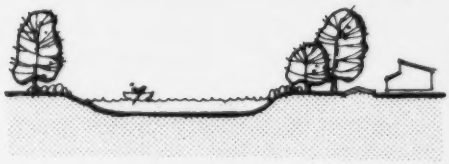
Site development should be planned to preserve natural opportunities for storm water drainage such as channels, swales or temporary retention ponds.

Natural drainage channel system

Diagnostic Question

YES

NO



Design Measure

The use of holding ponds and increased ground cover should be considered.

- With current methods of treatment, excessive storm water would overload a system and could flush untreated sewage into a discharge area. In order to avoid this, costly parallel systems may have to be constructed creating additional problems of soil erosion and downstream siltation.

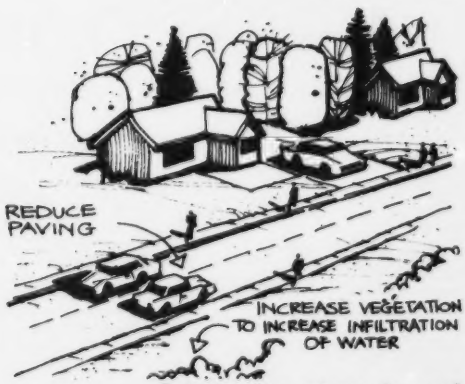
  Site planning can provide for storm water management on site rather than causing problems in a larger system.

  Stormwater can be held in temporary areas from which water is gradually released, or in permanent ponds.

- The amount of paving and other impervious surfaces can be reduced in order to permit a greater portion of storm water to seep into the ground.

- Vegetation and ground cover can be increased or retained in order to maximize the stormwater consumed or stored by plant materials.

Use of retention ponds

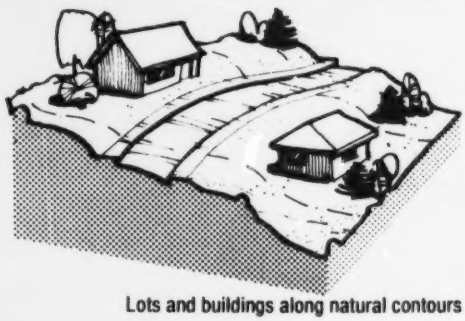


Reduction of impervious surfaces and retention of ground cover

DRAINAGE AND SITE PREPARATION 20

Principle

Lots or buildings should be sited to run along existing contours so as to minimize the need for cut and fill.



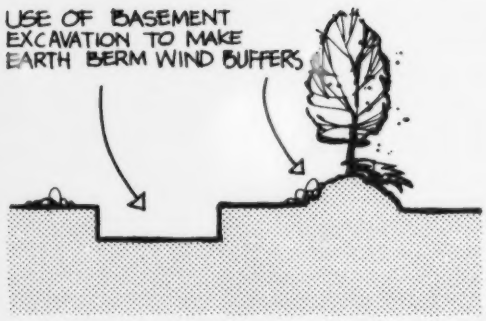
Lots and buildings along natural contours

Diagnostic Question

Design Measure

Terracing of lots should be considered.

- Buildings can be run along the contours of the land, molding construction into the site. By bending a linear cluster of buildings parallel to land contours, cut and fill as well as end wall construction is minimized. This results in reduced energy use by lessened requirements for grading. This concept of contour clustering also permits a major reduction in road lengths.
- In predominately flat sites, excess dirt excavated during construction can be retained for use as earth berms to control wind flow, reducing petroleum usage to transport materials off-site.
- Single family lots can be terraced to reflect natural changes in grade, with road ways running parallel to the contours as much as possible.

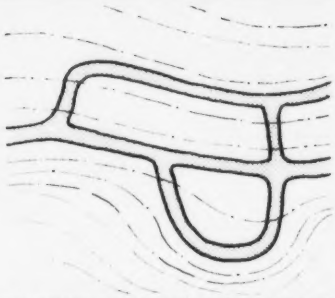


Use of cut on-site

DRAINAGE AND SITE PREPARATION 21

Principle

Streets and parking areas should be located to run along existing contours so as to minimize the need for cut and fill.



Streets and parking areas running along contours

Diagnostic Question

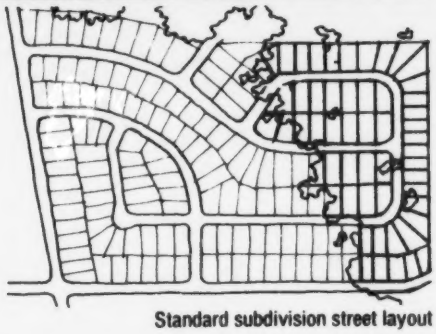
Design Measure

Streets should be redesigned to run parallel to the natural contours of the site as much as possible.

STREET LAYOUT 22

Principle

Street lengths should be reduced by using cul-de-sacs and/or narrower and deeper lots.



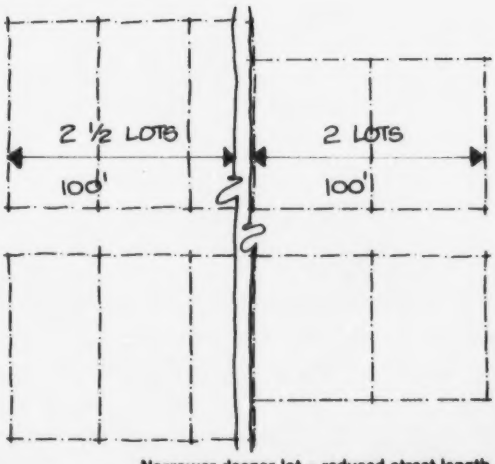
Standard subdivision street layout

Diagnostic Question

Design Measure

Redesign street system considering cul-de-sacs, narrower and deeper lots, and elimination of lanes.

- It is possible to design most residential subdivisions with no more than 20% of the developable land used for road right-of-way, assuming the normal 10% dedication for municipal and school reserve.
- For conventional single family subdivision it takes approximately 2.6 million BTU to prepare and install each linear foot of street.
- A slightly narrower but deeper lot reduces the ratio of roads to lots, increases density and can, when combined with a zero side yard layout provide more usable yard space.
- A laneless 15M right-of-way will provide approximately a 15% increase in net density over the current laned subdivision. Servicing can still be accommodated in the street with a 3.5M front easement for gas and telephone. Overall the area required for road-lane rights-of-way can be reduced by up to 45% when compared to the 17M road and 6M lane standard.



Narrower deeper lot = reduced street length

STREET LAYOUT 23

Principle

Narrower pavements can be introduced in small cul-de-sacs and where off street parking is used.

Diagnostic Question

Design Measure

Redesign street system, considering off street parking and narrower roadways.

- Narrower pavements could be introduced in small 5-12 lot cul-de-sacs where all houses are designed with a front drive garage or have a wide sideyard for access to the rear of the lot where parking is planned as an integral part of the design.
- The current 10M pavement width for residential streets is based on the need for two 2.75M driving lanes and two 2.25M parking lanes. If on-street parking could be replaced by offstreet the pavement width could be reduced to 6M. Such a reduction can result in 30% decrease in pavement costs, an increase in front yard space and a savings of 10% in energy costs.

Pedestrian Circulation

Pedestrian Circulation

Walking and the use of bicycles can be encouraged as a substitute for the automobile if a continuous and protected pedestrian system is planned as an integral element of a subdivision.

Planning needs to ensure continuous links are established from a site to schools, recreation areas, shopping and bus stops, which may be located adjacent to a site.

To complete the **Diagnostic Question** sequence for **pedestrian circulation**, the following information will be necessary.

Information Required	Sources
1. walking and bike-path location	Site plan (as submitted)
2. predominant winter wind direction	Topo-Climatic Map, CLIMATIC DESIGN AND DATA (p. 55)

ON-SITE PEDWAY AND BIKEWAY DESIGN 24

Principle

Pedestrian walkways and bikepaths should be encouraged as a substitute for the automobile.

Diagnostic Question

Design Measure

Provide pedestrian walkways and bikepaths.

Three classes of bikeways can be considered:

Bikepath - separated by physical space, earth berm, fence or other barrier, usually two way with an 8' minimum width

Bikeway - On-street facility striped from traffic with signs

Bike Route - Delineated only by signs

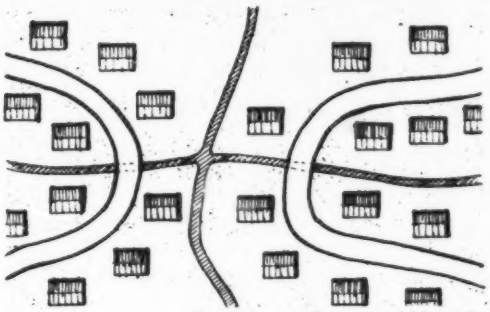
Where a roadway is used, certain minimum conditions should be satisfied:

- The route should be highly visible with signing and striping, crossings should be clearly marked
- Minimum widths of 6' in one bike lane and 4' from parked cars should be maintained
- The route should maintain continuity and not disappear where unresolved hazardous areas exist
- Grates for drainage should be straped or selected to accommodate riders
- Sidewalks should be used only for minimum distances
- Grade separation of bike intersections with arterial roads should be considered

PEDWAY AND BIKEWAY DESIGN 25

Principle

Pedestrian walkways and bikepaths should be continuous, linking areas and activities on the site and connecting to locations and paths adjacent to the site.



Continuous walkways and bikepaths

Diagnostic Question

YES

NO

Design Measure

Link off-site and on-site activities.

- Pedestrian paths should be planned to link various parts of the site and facilitate access to public open spaces and recreational areas.
- On-site paths should be planned to connect with activities adjacent or near to the site, such as play areas, public facilities or bus stops.
- Storage facilities for bicycles should be provided for in recreation areas, public facilities, areas adjacent to bus stops.

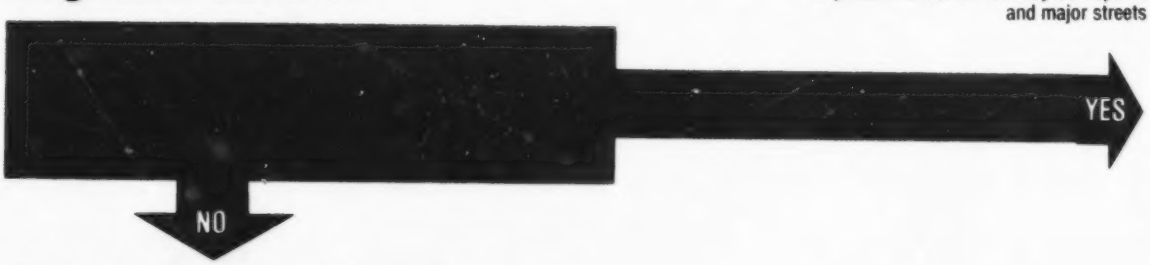
PEDWAY AND BIKEWAY DESIGN 26

Principle

Pedestrian walkways and bikepaths should be separated as much as possible from major roads with crossways readily visible by vehicles.

Separation between walkways, bikepaths and major streets

Diagnostic Question



Design Measure

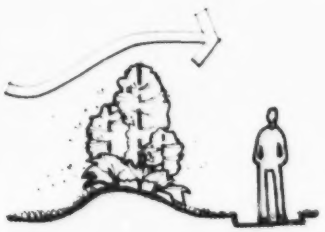
Roadways should be distinctly separated from walkways and bicycle paths.

- Visible and clearly marked crossings should be provided for bicycle traffic.

PEDWAY AND BIKEWAY DESIGN 27

Principle

Vegetative windbreaks, earth berms should be used to redirect winds and prevent snow drifting.



Walkways and bikepaths protected from winter winds

Diagnostic Question

[redacted] YES

NO

Design Measure

Plan location of windbreaks or earth berms to redirect winds and prevent snowdrifting.

[redacted]

Making Trade-Offs

In certain cases, climate or site characteristics m .y not make it possible to achieve all conditions favorable to energy efficiency. When conflicts occur, it may be necessary to decide which conditions are more important to attain. Guidelines for making "tradeoffs" involving two of the more significant potential conflicts are presented in the material which follows:

1. **Solar versus Wind Exposure** - where the predominant winter winds originate from the south, southeast or southwest; and
2. **Exposure to Winter Winds versus Access to Summer Breezes** - where predominant winter and summer winds originate from the same direction.

   Relevant wind direction and velocity data for various locations in Alberta, may be found in the Appendix section of the booklet: CLIMATIC DESIGN AND DATA.

TRADE-OFF 1

Solar versus Wind Exposure

Which is more important?

For the foreseeable future it is likely that only a minority of houses will be designed with active or passive solar systems. However with technological changes and greater public awareness, solar additions may be made, particularly those that also add other amenities such as greenhouses or attached sunspaces.

Passive solar approaches could provide 20-30% of the annual space heating load for a conventionally built single family home. Solar assisted hot water systems can provide 50-60% of the annual needs.

Winter winds can significantly increase space heating requirements. This is particularly the case in conventional homes built to code. The full benefit from energy efficient construction can be realized if such homes are sited so that the longer wall surfaces, window and door openings are not exposed to winter winds.

Heat loss from infiltration and disturbance to the still air film which surrounds outside walls and windows varies significantly as a function of exposure to wind and its velocity. It has been estimated that an increase in wind speed from 8 to 32 km./hr. can result in an increase in fuel required for space heating of 25%.

A Guiding Principle

Where conflicts between achieving both solar exposure and protection from winter winds cannot be resolved, the site plan decision should favor protection from winter winds over achieving south lot orientation.

Setting a Target

The actual number of lots that can be planned to be oriented to the south or southeast will vary depending upon topography, the location of exisiting vegetation and other conditions on the site.

However, since many sites in Alberta are relatively flat with minimal vegetation, site planning should aim at achieving south or southeast orientation for 75-80% of all lots.

TRADE-OFF 2

Exposure to Winter Winds versus Access to Summer Breezes

Why is exposure to summer breezes important?

Lots can be planned so that homes can take advantage of summer breezes to provide natural ventilation during the cooling season.

A Guiding Principle

Calculated from heating degrees days as compared to cooling degree days, heating requirements are typically 150 to 400 times more than space cooling needs.

Where conflicts between achieving access to summer breezes or protection from winter winds cannot be resolved, the site plan decision should favor protection from winter winds over achieving exposure to summer breezes.

Approaches to resolve conflicts

Design measures that can be used to lessen the negative effects from winter winds have been presented in Diagnostic Questions Sequence #1 and #2. These measures include: the use of earth berms, fences and walls, the placement of primary or accessory buildings and the use of vegetation.

Vegetation and landscaping, often used in combination with earth berms, offers the most flexible means for managing winter winds while preserving solar exposure.

The Section — The Selection and Use of Vegetation for Wind Management and Solar Exposure — in the booklet — CLIMATIC DESIGN AND DATA — provides a description of important considerations in order to use landscaping effectively.

ACKNOWLEDGEMENTS

This kit is the result of a collaborative process involving many people and agencies. The input and advice from a number of energy professionals and land use planners are greatly appreciated. Any omissions or errors, however, are the sole responsibility of the Project Team.

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FIELD TESTING AND REVIEW

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